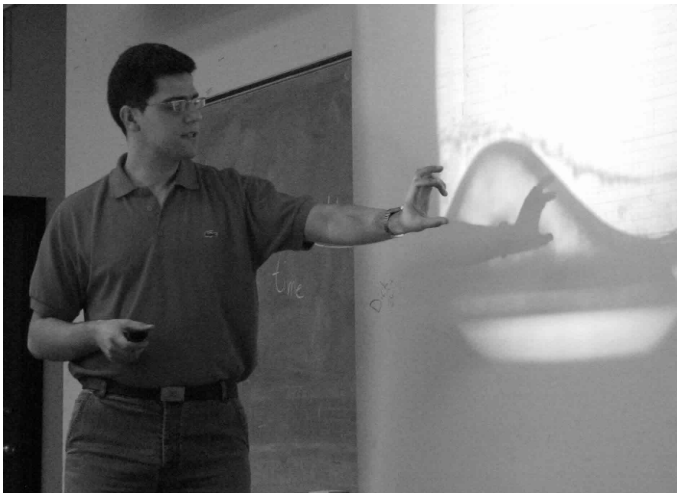
Teaching Dossier



By

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Contents

Chapter 1

Approach to Teaching

May I teach them faithfully the things they need to know, so they may face the future knowing they're prepared, and when they think of school days, may they know their teacher cared. – R. Fogle

1.1 Philosophy

Teaching is to spark curiosity in students and to help them develop abilities to think analytically. I believe a good teacher is a dedicated scholar who fosters students' learning by introducing them to a fresh angle of looking into the subjects seen in their real lives. My goal is to integrate my research and teaching, so my knowledge from carrying out advanced research can be used to design an innovative and insightful learning environment for students to build analytical skills.

Knowing students diverse backgrounds and understanding their different expectations is the first step in my approach to teaching a class. This helps me to adjust my teaching strategies according to their needs. In the beginning of the semester students fill out my designed questionnaire to reflect their background and indicate their expectations from the course (see supporting document [4.2]). This questionnaire helps me to know students' names as I often call students by name in the classroom. I also tell the students who I am and why I am teaching them, thus I deliver a presentation about myself and my research background in the first session of the class. (see supporting document [4.2])

The next step is to light a fire for learning. I usually start a new topic in the classroom by linking the topic to real life. For instance, before talking about the colors of combustion flames I ask the class how you decide if a fire is good enough for your barbecue; it is by looking into the color of fire! Students love real life connections as it gives them a sense of achievement when they begin looking at their surrounding environment differently. Engineering classes typically lack students' engagement and I found methods of active learning are powerful tools that increase student engagement in the classroom. I usually use these techniques in my class. For instance, I often plan discussion activities in the

class where students are asked to make a group with 4-5 students around themselves and discuss the proposed subject (see sample supporting document [4.4]). Then I challenge the class with questions that can come from their own responses. Students tended to enjoy these discussions and they also learn from their peers.

In the range of teaching strategies I use, I find giving constructive feedback to students and promoting their self-assessment is particularly effective. I often use certain periods of the class time to point out common misunderstandings among the students and to review their mistakes in assignments and exams. This provides me with an opportunity to make suggestions for improvement. Also, I prepare a comprehensive solved example set for each chapter of the course that includes questions with different level of complexity for students to practice and verify their answers. Students are also provided with sample practice exams to perform their own self-assessment.

1.2 Goals, Strategies, and Evaluation Methods

My top three teaching goals are:

- to clearly explain the fundamentals of the subject at a level appropriate to students; to help the students develop abilities to think critically and analytically by involving them in practical projects;
- to inspire students for research in engineering and science by introducing them to a fresh angle of looking into the subjects seen in their real lives;
- to help students build up the required skills to design and analyze engineering projects.

To reach the above teaching goals, I have used the following strategies:

- designing the course calendar to have a concrete plan for each session of the course; designing questionnaires in the beginning of classes to know students' knowledge background; designing course websites to help students review lectures (see supporting documentations [4.1] and [4.2]);
- using a variety of educational tools for students with different learning styles; showing movies and animations pertinent to the course subject; bringing equipment

models for students for illustrations; using educational simulation softwares and incorporating them in class examples and assignments; taking the class to the laboratory to perform/observe experiments, thus students can make a connection between the theory and the real practice. (see supporting documentations [4.3]);

- explaining students what the knowledge from this course will enable them to do; linking the course to real life by using practical examples in the class notes and designing assignments which deal with the recent topics and also including real life questions in the exams. (see supporting documentation [4.4]);
- increase class participation by using active learning methods (see supporting documentation [4.4]); using interactive discussions with the class starting with simple questions, then asking more analytical questions; sharing my research related problems with students and encouraging them to share their related experiences;
- providing constructive feedback to the students by meeting with students individually; receive feedback of my teaching from students by using a midterm feedback questionnaire and discuss suggested improvements with the class (see supporting documentation [4.2]); providing help to meet the special needs of students whose disabilities involve any difficulties for learning; providing solved examples, practice questions and sample exams for each main chapter of the course material to help students to monitor their own thinking and promote their self-assessments;
- creating a clear expectation framework of course targets and set up a clear procedure for evaluating students; familiarize students with the exam format by using similar style questions in assignments; providing students with a suggested studying model for the exam to emphasize on the priorities; holding exam review sessions (see supporting documentation [4.5]);

Evaluation of student learning is based on students' performance in assignments, course projects, mid-term and final exams. I often use two midterms as it provide more feedback to the students and also provides an extra chance for students who did not do well in the first exam. Exam questions are designed in such a way as to be able to test students' understanding of fundamental concepts and to test their abilities to solve problems. The answer to the questions requires creative and analytic thinking rather than mechanical memorizing, thus students are allowed to bring their own formula sheet.

Chapter 2

Teaching Contributions

2.1 Teaching Responsibilities

2.1.1 Michigan Tech University

I have been appointed as an assistant professor of Mechanical Engineering at Michigan Tech University since August 2012. Table 1 lists the courses I have taught as a principle instructor. Special Topic courses are denoted as "ST" and they refer to graduate level *reading* courses which does not necessarily follow typical lecture style sessions. Students in ST courses work on course materials by themselves and instructor foster students' learning through class discussions (twice a week), course projects, and homework assignments.

Table 1: Courses I Have Taught as a Principle Instructor. ST stands for Special Topic.

Course Number	Title	Term	Students (#)
MEEM 6990 (ST)	Optimal and Model Predictive Controls	Fall 2013	7
MEEM 5990 (ST)	Design and Instrumentation of HEV-LTC Engine Test Setup	Fall 2013	2
MEEM 2200	Thermodynamics	Spring 2013	26
MEEM 5990 (ST)	Experiment and Simulation of LTC Engine in HEV Powertrain	Spring 2013	4
MEEM 5990 (ST)	HCCI Engine Control	Fall 2012	1

2.1.2 KNT University of Technology

I was appointed as a visiting assistant professor for Winter 2010 semester at KNT University of Technology. I taught the two following technical elective undergraduate courses:

Table 2: Courses I Have Taught as a Principle Instructor at KNTU

Course Number	Title	Term	Students (#)
ME16-31	Deign of Combustion Engines	Winter 2010	28
ME19-31	Environmental Pollution Control	Winter 2010	32

2.1.3 University of Alberta

I was appointed by the Department of Mechanical Engineering as course instructor/teaching assistant for 10 academic terms. Table 3 lists the courses I have instructed at the University of Alberta from 2004 to 2009.

Table 3: Courses I Have Taught as Principle Instructor (PI) or Teaching Assistant (TA)

Course Number	Title	PI / TA	Term	Students (#)
MEC E 541	Combustion Engines & Alternative Fuels	PI	Fall 2009	50
MEC E 541	Combustion Engines & Alternative Fuels	PI	Fall 2008	28
MEC E 541	Combustion Engines & Alternative Fuels	TA	Winter 2009	30
MEC E 330	Fluid Mechanics	TA	Winter 2008	77
MEC E 330	Fluid Mechanics	TA	Winter 2007	84
MEC E 330	Fluid Mechanics	TA	Fall 2006	92
MEC E 420	Feedback Control Design	TA	Winter 2006	42
MEC E 330	Fluid Mechanics	TA	Fall 2005	104
MEC E 420	Feedback Control Design	TA	Winter 2005	44
MEC E 330	Fluid Mechanics	TA	Fall 2004	123

As the principle instructor of the graduate course (MEC E 541), I had the full responsibility of the class with duties including delivering lectures three times a week, preparing assignments/exams, preparing extra studying resources and providing feedback to the students.

My TA duties included: (i) delivering lecture-style sessions with demonstrating and running the experiments two sessions a week in MEC E 330; (ii) Grading lab reports/course assignments/mid-terms, setting up laboratory equipment and demonstrating experiments four sessions a week in MEC E 420; (iii) improving the course notes, preparing the solutions for assignments, marking assignments and holding office hours to answer students' questions in MEC E 541.

2.2 Mentoring Students

2.2.1 PhD Students (9)

- M. R. Amini, PhD thesis adviser, Adaptive fuel powertrain controls, Michigan Tech University, 2013 - now.
- M. Bidarvatan, PhD thesis adviser, Modeling and control of HCCI integrated hybrid electric vehicles, Michigan Tech University, 2012 - now.
- M. Razmara, PhD thesis adviser, Control of building energy in smart grid, Michigan Tech University, 2012 - now.
- B. Bahri, PhD thesis co-adviser, Investigation of HCCI engines fueled with ethanol blends, University Technology Malaysia, 2010 - 2013.
- M. Nazoktabar, PhD thesis co-adviser, Thermo-kinetic modeling and control of HCCI combustion with butanol fuel, KNT University of Tech, 2010 - now.
- R. Salehi, Visiting PhD candidate from Sharif University, Hybrid switching controller for cold start emission reduction, University of California, Berkeley, 2012.
- S. Pan, PhD candidate, Adaptive sliding controller design with robustness to implementation imprecision, University of California, Berkeley, 2012.
- K. Edelberg, PhD student, Robust model-based controller design using implementation imprecision bounds, University of California, Berkeley, 2012.
- Y. Chen, Visiting PhD candidate from Jilin University, Control of engine emissions during cold start, University of California, Berkeley, 2010 - 2011.

2.2.2 MSc Students (27)

- D. Kothari, MSc thesis adviser, Control of exhaust gas temperature for LTC engine exhaust aftertreatment system, Michigan Tech University, 2013 - now.
- H. Saigaonka, MSc thesis adviser, Experimental and simulation study of LTC engine with Variable Valve Actuation (VVA), Michigan Tech University, 2013 - now.
- K. Khodadadi, MSc thesis adviser, Control of RCCI engines using multiple fuel injection strategies, Michigan Tech University, 2013 - now.

- V. Thakkar, MSc thesis adviser, Experimental and simulation study of a hybrid electric powertrain using a low temperature combustion IC engine, Michigan Tech University, 2013 - now.

- A. Solouk Mofrad, MSc thesis adviser, Control of a hybrid electric powertrain utilizing a LTC engine, Michigan Tech University, 2013 - now.

- J. Dobbs, MSc thesis adviser, Model-based building HVAC controls, Michigan Tech University, 2013 - now.

- M. Paranjape, MSc thesis adviser, Building grid energy optimization, Michigan Tech University, 2013 - now.

- M. R. Nazemi, Short term scholar, Modeling of RCCI engine combustion, Michigan Tech University, 2013 - now.

- F. Ahmed, G. Xiong, A. Ketkale, A. Kondra, A. Girase, and H. Su, Short term scholars, Experimental setup for low temperature combustion engine research, Michigan Tech University, 2013 - now.

- Z. Han, S. Viswanathan, Z. Huang, and N. Ghike, Short term scholars, Control of electric motor and Lithium-ion battery for HEV powertrain, Michigan Tech University, 2013 - now.

- B. Moridian, Short term scholar, Adaptive parameter/state estimation for building energy control, Michigan Tech University, 2012 - 2013.

- A. Hansen, Visiting M.Sc. student from Technische Universitt Hamburg-Harburg, Discrete sliding mode control of automotive controllers, University of California, Berkeley, 2012.

- A. Cranmer, MSc student, Modeling HC tailpipe emissions from an SI engine, University of California, Berkeley, 2010 - 2011.

- M. Amini, MSc thesis co-adviser, Model-based control of cold start hydrocarbon emissions in SI engines, KNT University, 2011 - 2012.

- M. Boodaghi, MSc thesis co-adviser, Strategies of misfire detection in gasoline-CNG bi-fuel engines, KNT University, 2010 - 2011.

- M. Marami, MSc thesis co-adviser, Simulation of oil circuit in a SI engine at cold start transient conditions, KNT University, 2010 - 2011.

- M. Dehghani, MSc thesis co-adviser, Thermodynamic modeling of HCCI exhaust temperature, KNT University, 2010 - 2011.

- M. Bidarvatan, MSc thesis co-adviser, Control of combustion phasing in an HCCI engine, KNT University, 2010 - 2011.

- S. Sharifirad, Visiting MSc student from KNT University, Automatic driver controller design for standard driving test cycles simulation, Iran Khodro Engine Research Center, 2003 - 2004.

2.2.3 BSc Students (22)

- A. Soneji, R. Bhasin, A. Neti, N. Neti, A. Hayashi, S. Bigdeli, S. Raghunathan, Mech. Eng. undergraduate students, Modeling, control and testing of a 2.4-liter Toyota engine and exhaust aftertreatment system, University of California, Berkeley, 2012.

- J. Li, and A. Cheng, Senior Mech. Eng. undergraduate students, Verification and hardware-in-the-loop testing of automotive controllers, University of California, Berkeley, 2012.

- M. Muller, P. Sang Cho, and R. Sze, Senior Mech. Eng. undergraduate students, Model analysis and control trajectory modification for reducing hydrocarbon emissions in SI engines, University of California, Berkeley, 2011.

- A. Solook Mofrad, BSc thesis co-adviser, On-board diagnosis of catalytic converters in SI engines, KNT University, 2010.

- A. Kazemi Taskoh, BSc thesis co-adviser, Control strategies to reduce cold start and warm-up emissions from passenger cars, KNT University, 2010.

- M. Aliramezani, BSc thesis co-adviser, Control strategies of Anti-lock Braking Systems (ABS) in passenger cars, KNT University, 2010.

- J. Rezaee, BSc thesis co-adviser, Experimental study of an HCCI engine running with butanol blended fuels, KNT University, 2010.

- A. Shahrokhshahi and H. Zamani, BSc thesis co-adviser, Strategies to control/monitor evaporative emissions in passenger cars, KNT University, 2010.
- H. Jafarian, BSc thesis co-adviser, Simulation of bearings of a SI engine using AVL-EXCITE software, KNT University, 2010.
- M. Amereh, BSc thesis co-adviser, Numerical modeling of the flow under engine's hood of Samand vehicle using Fluent software, KNT University, 2010.
- S. Varnhagen, NSERC summer student, HCCI experimental study, University of Alberta, 2008.
- K. Swan, NSERC summer student, HCCI combustion modeling, University of Alberta, 2006.

2.3 Activities Undertaken to Improve Teaching and Learning

To improve my teaching and learning I enrolled in the University Teaching Program (UTP) during 2004-2009 at the University of Alberta. UTP was offered for graduate students by the Faculty of Graduate Studies and Research (FGSR) and the University Teaching Services (UTS) with the aim to develop an ethical, philosophical and practical basis for teaching in post-secondary institutions. Within this program I finished 50 hours of formal classroom training which covers a wide range of theoretical and practical teaching topics through 35 different seminars and workshops I attended. A complete list of these sessions is enclosed to this teaching dossier.

Since effective teaching strategies vary from one discipline to another, learning from Engineering professors with excellent teaching records is of great benefit to me. To this end, I attended teaching seminars organized by the Faculty of Engineering in Jan.-Mar. 2008. I found these seminars very useful because the invited professors illustrated new and interesting approaches by showing examples of how to deal with difficulties and how to explain challenging subjects in the Engineering discipline. In addition, I attended a 1-day workshop on *Effective Teaching* in the Faculty of Engineering in August 2008. The workshop was offered by distinguished professors in the Faculty of Engineering and it was designed for faculty members. In this workshop, I learnt about using active learning techniques in teaching Engineering subjects. Later during the 2008 fall term, I implemented

these teaching techniques in the subject I taught and I received a lot of positive feedback from the students.

Close interaction with my teaching mentor, Professor M. Dave Checkel, has been a great teaching training experience for me. Prof. Checkel has been the instructor of MEC E 541 for over 20 years with an outstanding teaching record in Mechanical Engineering Department. I had a discussion meeting with Prof. Checkel regularly every week during the 2008 fall term when I was teaching MEC E 541. I discussed with him my thoughts on the approaches to deliver a profound understanding of the subject to the students. Prof. Checkel's mentorship has provided me with an excellent practical on-job teaching training.

2.4 Committee Service regarding Teaching Issues

2.4.1 Teaching seminars in the Faculty of Engineering

I organized and coordinated a series of teaching seminars entitled "What Contributes to Successful Teaching in Engineering" in the Faculty of Engineering in 2008. The seminars were sponsored by Mechanical Engineering Graduate Student Association (MEGSA) and the Department of Mechanical Engineering. Six distinguished professors were invited to share their experience with graduate students in the Faculty of Engineering. Here is the list of the seminars held:

1. Dr. M. G. Faulkner and Dr. P. Flynn, Engineering Teaching and Learning Complex (ETLC), University of Alberta, Jan., 24, 2008.

2. Dr. S. Karapetrovic and Dr. L. W. Kostiuk, ETLC, University of Alberta, Feb., 28, 2008.

3. Dr. M. D. Checkel and Dr. L. W. Sigurdson, ETLC, University of Alberta, Mar., 28, 2008.

About 150 graduate students from four engineering departments attended these three teaching seminars.

2.4.2 Workshops for Alberta teachers

I designed and co-organized three different workshops for the teachers from Alberta high schools during 2005-2007. The purpose of these workshops was for teachers' professional

development by learning about recent studies in the University. My activities regarding these workshops are listed below:

1. Designed and delivered a workshop on "HCCI Engines and Advanced Methods to Improve Emissions of Motor Vehicles" in the 81^{th} Annual GETCA Convention (Greater Edmonton Teachers Convention Association), Shaw conference center, Edmonton, March 1-2, 2007.

2. Organized the Faculty of engineering workshop in Heritage Youth Researcher Summer (HYRS) Teachers Workshop supported by Alberta Heritage Foundation for Medical Research (AHFMR), University of Alberta, July 25-26, 2006. I also delivered a lecture on the topic of "Vehicles Emissions".

3. Co-organized a workshop in Mechanical Engineering Department for HYRS Teachers Workshop, University of Alberta, August 8-10, 2005. I also served as the lecturer on the topic of "Engineering Solutions for Automotive Emissions".

2.4.3 Science workshops for high school students

As a volunteer in the national Let's Talk Science program (www.letstalkscience.ca), I contributed over 150 hours for a period of several months to design and prepare a workshop to engage students for having a better understanding of the topics in their science course. In particular, two different workshops were designed and carried out for the students in WestMount Jr. High School on March 14, 2008 in Edmonton. The work was done with collaboration with a science teacher from the school and another graduate student (Dr. Nima Yusefi).

In the first workshop, I visualized flow characteristics for students and explained to them how flow properties become important in engineering designs. In the second workshop, students learnt how an engine and transmission system work in cars in order to produce/transmit work. I used models of engine and transmission systems to explain to them how energy is changed from chemical to mechanical state by igniting the fuel in an engine and using a moving mechanism to transfer energy to the wheels of cars. They could play with models and they could see different possible ways of moving components in the system to create/transmit work. This workshop was well aligned with their course syllabus since they were learning about machines and how they can help human being to produce positive work. The workshops were done for 170 students from classes in different grades at WestMount Jr. High School.

Chapter 3

Reflections on and Assessment of Teaching

3.1 Documentation of Results of Teaching

The results of the students' evaluations (available to me) for the courses I have served as a Teaching Assistant have been provided in this teaching dossier (see supporting documentation [4.6]). The whole record of my TA performance through my teaching duties can be found in my academic file with the Department of Mechanical Engineering at the University of Alberta. As a result of my satisfactory commitment to my TA duties for six academic terms, I was privileged to be TA for two extra terms in 2008 and 2009.

Teaching a graduate course by a graduate student is very rare in the Department of Mechanical Engineering at University of Alberta before 2008. However, my successful TA records and support from supervisor (Prof. C. R. Koch) and my teaching mentor resulted in selecting me as the principle instructor of the graduate course MEC E 541 in 2008 Fall term. My teaching evaluation results for this course have been provided in this teaching dossier (see supporting documentation [4.6]). I received the overall rating of 4.7 out of 5 which is a very high rating among over 450 instructors who taught a 500 level course at the University before. As a result of this achievement, Professor M. D. Checkel (my teaching mentor) nominated me for Zita and John Rosen Teaching Award for graduate student principal instructor and I received this award in 2009. A copy of the support letter from my teaching mentor for the award application is included in this teaching dossier (see supporting documentation [4.7]). Again I was appointed by the Mechanical Engineering Department to teach MEC E 541 in the 2009 fall term.

After I graduated from PhD program at University of Alberta, I continued to teach as principle instructor for Mechanical Engineering courses including i) Design of internal combustion engines (KNTU), ii) Environmental pollution control (KNTU), and iii) Thermodynamics (MTU). Student evaluations for my teaching excellence for these courses

ranged from 88% to 98%.

Awards received for teaching and service activities

- Zita and John Rosen Teaching Award for Principal Instructor, University of Alberta, 2009. The purpose of this award is to give special recognition to a graduate student Principle Instructor who is an especially skilled and dedicated teacher. Principal Instructors are those who are fully responsible for a course, including lecturing, course and lecture planning, preparing and grading assignments and examinations, etc. The three adjudication themes are: Excellence and innovation in teaching, Leadership in engaging students, and Contribution to teaching and the University community. Only one award is given each year. Copies of support letters from three of my students for this award nomination have been provided in this teaching dossier. (see supporting documentation [4.7])
- Award for Outstanding Volunteer Contribution for "Most Youth Reached" in National Let's Talk Science Program, University of Alberta, 2008. This award recognizes my efforts in designing and performing educational workshops for students in WestMount Jr. high school in Edmonton in 2008. (supporting documentation [4.7])
- Alan Wharmby Memorial Graduate Award in Mechanical Engineering, University of Alberta, 2008. This award recognizes the activities including *Teaching Seminars* that I organized and coordinated within the Department of Mechanical Engineering in 2007-2008. These graduate students *Teaching Seminars* were done for the first time in the Faculty of Engineering at the University of Alberta. (see supporting documentation [4.7])

3.2 Future Plans

Teaching in the classroom is a dynamic learning experience for me since I can learn which teaching strategies work best for the students in different classes. There are three areas of my teaching that I would like to continue to develop in the near future. First, I would like to design more active learning activities for different areas in each subject I teach, so I can use them whenever students need extra practice and discussions to understand each particular topic of the course. I want to practice more new techniques I learned in 2013 active learning workshops at Michigan Tech University. Second, I would like to include

more real life examples for the Engineering subjects I teach and possibly arrange industrial visits from the companies which work in the area related to the topic of the course. Third, I would like to develop new courses that coincide with my research background and interests. These include courses like "Alternative Vehicle Propulsion Systems", "Advanced Energy and Fuel Solutions", and "Energy Mechatronics". I also plan to keep a teaching journal to stimulate self-reflection on my teaching learning experiences, thus my long-term goal of developing an effective personal teaching style can be accomplished.

Chapter 4

Supporting Documentation

The following is a complete list of the documents provided in this teaching dossier as supporting documentation.

[**4.1**] the course outline of MecE 541 Fall 08; the course calendar of MecE 541 Fall 08; the course website of MecE 541 Fall 08;

[**4.2**] presentation in the first session of MecE 541 Fall 08; sample questionnaire used in MecE 541 Fall 08; mid-semester feedback form to identify students' concerns;

[**4.3**] samples to demonstrate the use of different types of educational resources for teaching MecE 541 Fall 08: Engine animations, Engine cycle simulator software, Demonstration equipment, and Engine laboratory;

[**4.4**] sample designed active learning activity in teaching MecE 541; samples from including "real life" examples in the course notes, assignments, and exams in MecE 541;

[**4.5**] sample model for studying exams in MecE 541; final exam review for MecE 541 Fall 08;

[**4.6**] the course teaching evaluation results for MecE 541; available teaching assistantship evaluation results for the courses MecE 420 and MecE 330;

[**4.7**] the award letter and four letters of support from my teaching mentor and students for the 2009 Zita and John Rosen Teaching Award at the University of Alberta; award certificate for outstanding volunteer contribution in Let's Talk Science national program; letter of Alan Wharmby Memorial Graduate Award in Mechanical Engineering at the University of Alberta.

Supporting Documentation
[4.1]

Contents:

- The course outline of MecE 541 Fall 08
- The course calendar of MecE 541 Fall 08
- The course website of MecE 541 Fall 08

MEC E 541- Combustion Engines and Alternative Fuels Sept. 2008

INSTRUCTOR: Mahdi Shahbakhti Mec E 4-31A / 4-28 492-6155 M.Shahbakhti@ualberta.ca

CALENDAR DESCRIPTION: 3.0 (fi 6). History of basic cycles; combustion theory including ignition, flame propagation and engine knock; cycle analysis with deviations from ideal cycles and performance characteristics; fuels; design and operation of carburation and injection processes; exhaust emissions measurements. Identification of design parameters and their effects on emissions. Pre-requisite: MECE 340

TEXT(s):

Require	• **Mec E 541 Notes**	(Mec E Club)
Require	• Fundamentals of Classical Thermodynamics or equiv.	(i.e. your MecE 340 text)
Recommend	• Intro to Internal Combustion Engine Fundamentals, Stone	(SAE)
Reference	• Internal Combustion Engine Fundamentals, Heywood	(Library, SAE)

WEB PAGE: http://www.mece.ualberta.ca/Courses/mec541
The web page will have office hours information plus assignments.

COURSE OUTLINE:
1. HISTORY OF ENGINES and CYCLES
2. IDEAL GAS THERMODYNAMICS:
   Review Air Cycles and Gas Mixture Properties,
   Fuel/Air Mixtures, Reactions, Flame Temperatures and Pressures
3. EQUILIBRIUM COMBUSTION ANALYSIS
4. REAL MIXTURE CYCLE ANALYSIS AND IDEAL OTTO CYCLE ENGINES

********** **MIDTERM EXAM #1 * (F Oct.17, 13:00-13:50)** **********

5. ACTUAL COMBUSTION PROCESSES AND EFFECTS ON ENGINES
   Ignition, Flammability Limits, Burning Velocity, Kinetics, Knock
6. DIESEL ENGINE COMBUSTION AND CYCLE ANALYSIS

********** **MIDTERM EXAM #2 * (M Nov.17, 13:00-13:50)** **********

7. ENGINE CONTROLS, POLLUTANTS, EXHAUST TREATMENT
8. (optional) ALTERNATIVE FUELS AND ALTERNATIVE ENGINES

MARKS:

Assignments (about 5 or 6)	20%
Midterm Exam # 1 (Fri Oct.17, 13:00-13:50)	15%
Midterm Exam # 2 (Mon Nov.17, 13:00-13:50)	15%
Final Exam (Tue Dec. 16, 14:00)	50%

The exams will be closed book + formula sheet + thermo data sheet* (see web page)

Grades Policy: Grades are determined by a combination of typical distributions and absolute standards.

Calculator Policy: Only approved programmable or non-programmable calculators are allowed in exams. (details at: http://www.engineering.ualberta.ca/calculator.cfm)

Academic Dishonesty Policy: "The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behavior (online at www.ualberta.ca/secretariat/appeals.htm and avoid any behavior which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University."

Policy Policy: "Policy about course outlines can be found in §23.4(2) of the University Calendar. Nothing in any course outline, syllabus or course web-site may override or contravene any Calendar regulation or GFC policy. In resolving any discrepancy, GFC policy and Calendar regulations will take precedence."

Last update: 02/Sept. /2008

September 08 - MECE 541

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
September 1	2	3	4	5	6	7
Holiday Labour Day		Session #1 Introduction Course outline History		Session #2 History of engines History of fuels		
8	9	10	11	12	13	14
Session #3 Classification of engines What matter for engines		Session #4 Basic calculation for engines T, P, Rc, MEP,...		Session #5 Basic calculation for engines End of chapter 1		
15	16	17	18	19	20	21
Session #6 Chapter 2 Engine thermodynamics (1)		Session #7 A1 Engine thermodynamics (2) Cycles and examples		Session #8 Engine thermodynamics (3) Cycles and examples		
22	23	24	25	26	27	28
Session #9 Mixture formation & Chemical Reactions (1)		Session #10 Mixture formation & Chemical Reactions (2)		Session #11 Mixture formation & Chemical Reactions (3)		
29	30	October 1	2	3	4	5
Session #12 A2 Enthalpy of formation, LHV, ...						

October 08 - MECE 541

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
September 29	30	October 1	2	3	4	5
		Session #13 Adiabatic Temp. Enthalpy of reaction		Session #14 Complete chapter 2 material		
6	7	8	9	10	11	12
Session #15 Solve more examples on cycles End of chapter 2		Session #16 Chapter 3 Equilibrium combustion		Session #17 Equilibrium combustion (2) Dissociation Solve examples		
13	14	15	16	17	18	19
Holiday Thanksgiving		Session #18 Equilibrium combustion (3) Explain midterm		Midterm #1 By the end of chapter 2		
20	21	22	23	24	25	26
Session #19 A3 Review midterm STANJAN End of chapter 3		Session #20 Chapter 4 Engine cycle analysis (1) Otto comb.		Session #21 Engine cycle analysis (2) Diesel comb.		
27	28	29	30	31	November 1	2
Session #22 Engine cycle analysis (3) Different cycles		Session #23 Combustion in engines Flame speed, flame quenching..		Session #24 Flame speed (2) Diesel combustion		

November 08 - MECE 541

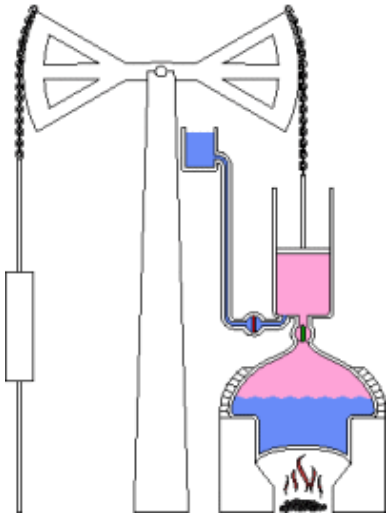
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
October 27	28	29	30	31	November 1	2
3	4	5	6	7	8	9
Session #25 Diesel Combustion (2)		Session #26 Explain Engine Sim. A4		Session #27 Knock (1)		
10	11	12	13	14	15	16
Fall term class break	Holiday Remembrance Day	Session #28 Knock (2) Complete chapter 4		Session #29 Solve sample examples End of chapter 4		
17	18	19	20	21	22	23
Midterm #2 By the end of chapter 4		Session #30 A5 Review midterm Chapter 5 Engine emissions (1)		Session #31 Engine emissions (2)		
24	25	26	27	28	29	30
Session #32 Engine emissions (3) Emission Control (1)		Session #33 Emission Control (2)		Session #34 Alternative fuels (1)		

December 08 - MECE 541

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
December 1	2	3	4	5	6	7
Session #35 Alternative fuels (2) Alternative technologies (1)		Last session #36 A6 Alternative technologies (2)				
8	9	10	11	12	13	14
15	16	17	18	19	20	21
	Final Exam 14:00					
22	23	24	25	26	27	28
29	30	31	January 1	2	3	4

MecE 541: Combustion Engines

Planned Offering:
Jan-Apr 2009: Prof. D. Checkel



INSTRUCTOR: Mahdi Shahbakhti

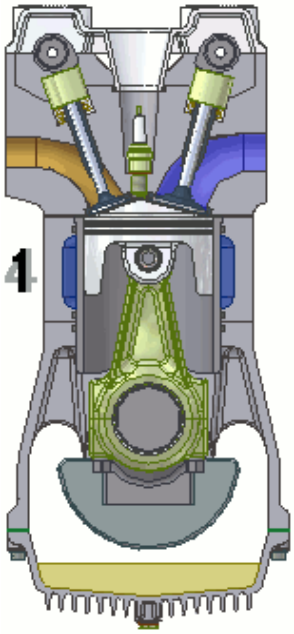
Office: Mec E 4-28 or 4-31A

Phone: 492-6155

Email: M.Shahbakhti@ualberta.ca

Office Hours: Mon. 14:00-16:00, Thu. 13:00-15:00

T.A: Ahmad Ghazimirsaied
Email: ghazimir@ualberta.ca
Office Hours: Tue. 14:00 - 15:00
Office Location: MecE 4-28



This web page will be periodically updated with announcements, assignments and course material.

Course Material	Assignments/Documentation
• Course Outline • Pre-Requisite Knowledge • Thermodynamic Data Sheet Tables of thermo data for assignments & exams. • Animation of Engines Powerpoint file of the animated engines presented in the class. • STANJAN and ENGINE_SIM • KNOCKSIM.EXE program • Emission Talk	**Assignment Guide** **Assignments** • Assignment 1 • Solution 1 • Assignment 2 • Solution 2 • Assignment 3 • Solution 3 • Assignment 4 • Solution 4

You may contact the instructor if you do not have the password to open the presentation. • Midterm Exams: #1 Fri. Oct. 17 ; #2 Mon. Nov. 17 • Review of Midterm #1 • Review of Midterm #2 • Final Exam: 14:00 Tue. Dec. 16 in room MecE 4-3 • Suggested Model for Studying Exam • Sample Exam 1 • Sample Exam 2 Note: These two samples are final exams from classes of Prof. Checkel. • Exam Guide (rules, formula sheet, etc.) • Final Review	• Assignment 5 • Solution 5 • Assignment 6 *(optional) • Solution 6 • **Note: *Assignment marks are based on best 5 assignments.**

- Return to MecE Graduate Courses

Supporting Documentation
[4.2]

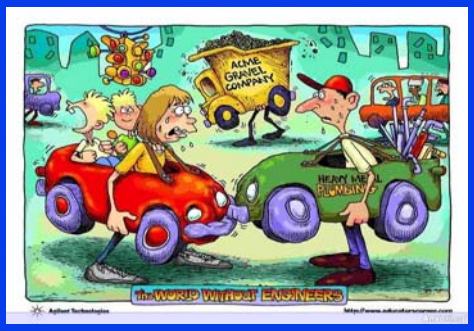
Contents:

- Presentation in the first session of MecE 541 Fall 08
- Questionnaire used in MecE 541 Fall 08 to learn about students background and expectations
- Mid-semester feedback form to identify students' concerns

Mec E 541
Combustion Engines

Mahdi Shahbakhti

World without mechanical (automotive) engineers!



What is Combustion Engines ?

- History of Engines, Fuels
- Thermodynamics of Gas Combustion
- Combustion in SI and CI Engines
- Emissions and Emission Control
- Alternative Fuels & Engines

Mec E 541: COMBUSTION ENGINES

- Instructor: Mahdi Shahbakhti
  - office: MecE 4-28 or 4-31A
  - phone: 492-6155
  - E-mail: M.Shahbakhti@ualberta.ca
- TA: Ahmad Ghazimirsaied
  - Office: MecE 4-28
  - hours: Tuesdays 14:00 – 15:00
  - E-mail ghazimir@ualberta.ca

Structure of the course, exam,… (see your handout)

MEC E 541- Combustion Engines and Alternative Fuels Sept. 2008

INSTRUCTOR:

CALENDAR DESCRIPTION:

TEXTs:

WEB PAGE:

COURSE OUTLINE:

MARKS:

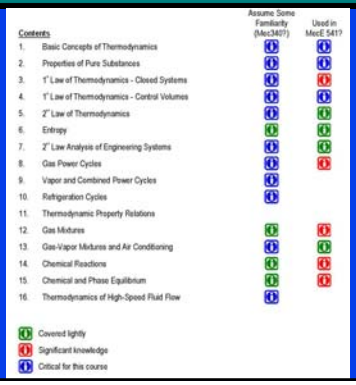
Grades Policy:

Calculator Policy:

Cheating Policy:

Policy Policy:

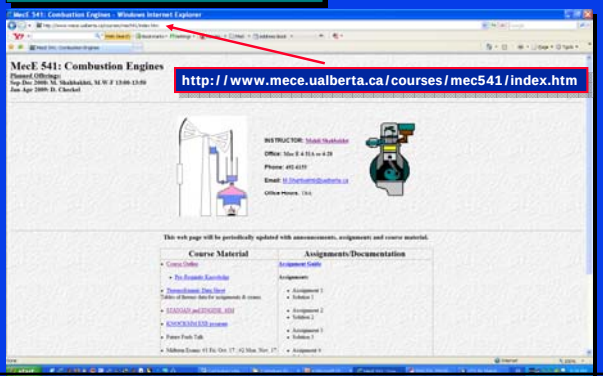
What do you need to know (pre-requisite)?



Contents	Assume Some Familiarity (Mec340?)	Used in MecE 541?
1. Basic Concepts of Thermodynamics	O	O
2. Properties of Pure Substances	O	O
3. 1st Law of Thermodynamics - Closed Systems	O	O
4. 1st Law of Thermodynamics - Control Volumes	O	O
5. 2nd Law of Thermodynamics	O	O
6. Entropy	O	O
7. 2nd Law Analysis of Engineering Systems	O	O
8. Gas Power Cycles	O	O
9. Vapor and Combined Power Cycles	O	
10. Refrigeration Cycles	O	
11. Thermodynamic Property Relations		
12. Gas Mixtures	O	O
13. Gas-Vapor Mixtures and Air Conditioning	O	O
14. Chemical Reactions	O	O
15. Chemical and Phase Equilibrium	O	O
16. Thermodynamics of High-Speed Fluid Flow	O	

O Covered lightly
O Significant knowledge
O Critical for this course

Website

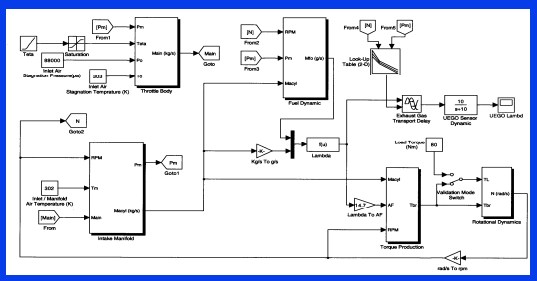


About me!

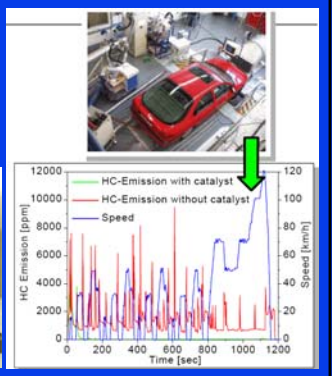
Mahdi Shahbakhti

- B.Sc. (MecEng) 2000
- M.Sc. (AutomotiveEng) 2003
  - Dynamic modeling of injection engines
  - Study of emissions in cold start & warm up
- Iran engine research centre (2001-2004)
  - Design of strategies for engine control unit
  - Calibration & benchmarking of engines
- Ph.D. student (U of A) since 2004
  - Modelling and control of HCCI engines

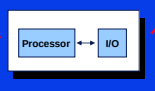
Some of the Past Research Activities
Simulation model of a MPFI engine



Calibration of engine on vehicle dynamometer

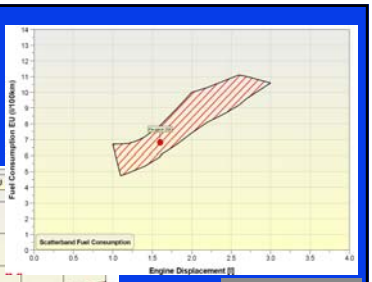


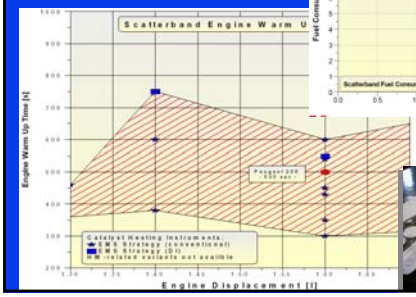
Design of ECU strategies & National Engine



Cold Start Tests and Engine Mapping

Benchmarking of engines





HCCI Engine (Ph.D.)

(Modeling and control of combustion)

MEC E 541: Who are YOU ?

- **Grad Students ? UnderGrads ?**
- **Mec E ? Chem E ? E E ? ??**
- **Pre-requisite:**
  MecE 340 Applied Thermodynamics

Office hours (?)

M. SHAHBAKHTI — SCHEDULE — FALL 2008

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:00					
9:00					
10:00					
11:00					
12:00					
13:00	MecE 541		MecE 541		MecE 541
14:00		TA Office Hour			
15:00					
16:00					
17:00					

Group activity:

What is your favourite car?
How do you describe your desirable engine?

Questionnaire - MEC E 541 (M. Shahbakhti)

Name:_____

Department:_____

Graduate / undergraduate:_____ Which year of program:__

1. **Do you have any prior experience / knowledge in engines? If yes, explain?**

2. **Why are you interested in taking this course?**

3. **What do you expect to learn in this course?**

4. **Is this your first related course in engines / combustion / fuel? If not, list other courses you have taken.**

MecE 541 Mid-Semester Feedback Form
Fall 2008
Instructor: Mahdi Shahbakhti

This is an anonymous and voluntary evaluation of the course.
The goal of this exercise is to identify and address students' concerns before the end of the term. If you wish to participate, please provide a rating on the following issues. Please return this questionnaire after class.

Please circle the number that you feel best represents your opinion.

1 - Strongly disagree; 2 - disagree; 3 - neutral or no opinion; 4 - agree; 5 - strongly agree

To date the structure and the pace of the course is excellent.

1 2 3 4 5

The type of assignments is helpful for understanding the course.

1 2 3 4 5

The instructor explains the concept clearly.

1 2 3 4 5

The instructor is well prepared.

1 2 3 4 5

The instructor demonstrates a good level of knowledge.

1 2 3 4 5

The relationship between the instructor and the students is excellent.

1 2 3 4 5

The instructor is accessible and provides feedback.

1 2 3 4 5

I am motivated to learn more about this course.

1 2 3 4 5

Is there anything that irritates you in the class?

How can this course be improved? (use back of this sheet if necessary.)

Supporting Documentation
[4.3]

Contents:

Use of different types of educational resources for teaching MecE 541 Fall 08:

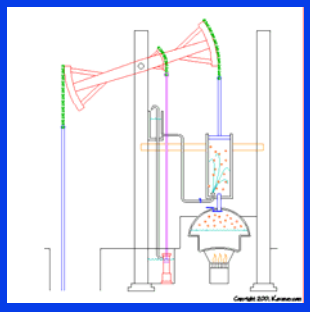
- Engine animations
- Engine cycle simulator used as an educational tool
- Sample equipment brought to classroom for illustration
- Engine laboratory for students to observe real experiments

Mec E 541

Parts of Combustion Engines
History in Action (engine animations)

Mahdi Shahbakhti

Newcomen engine



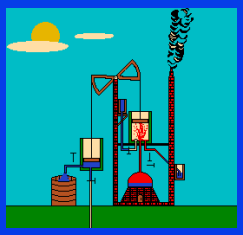
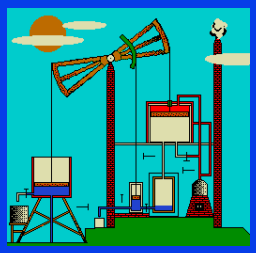


Image sources: http://animations.technologydiamonds.com/ ; http://www.keveney.com/newcommen.html.

James Watt steam engine



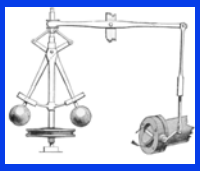
Inventions/improvements

- Double-acting cylinder
- Separate condenser
- Improve cylinder heating requirements

Image source: http://animations.technologydiamonds.com/

Other main inventions in James Watt engine

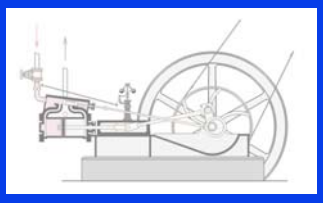
- Centrifugal governor

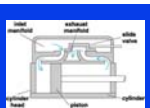


- Sun and planet gear, parallel linkage

Image sources: http://en.wikipedia.org

James Watt engine in action

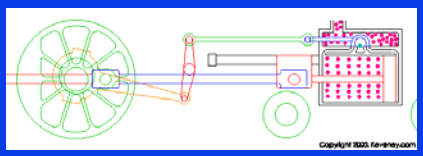


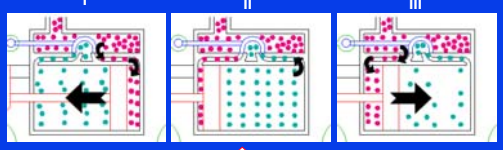


Single-ported slide valve on counterflow double-acting cylinder

Image sources: www.Answers.com

Steam engines in trains,… (Early 1800s to the 1950s)





Causes characteristic *choo choo* sound!

Image source: http://www.keveney.com/Engines.html

Conventional four-stroke engine

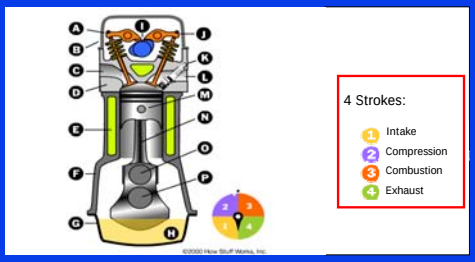
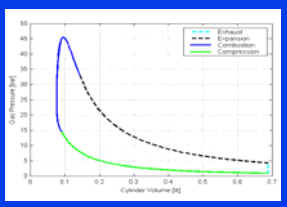


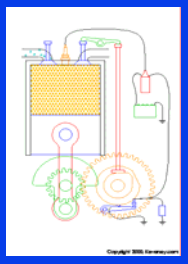
Image source: http://www.howstuffworks.com/

How is work measured in engines?

- **Work = Force x Displacement**

$$W = \frac{\text{Force}}{\text{Area}} \times (\text{Area} \times \text{Displacement}) = \text{Pressure} \times \text{Volume}$$





Conventional four-stroke engine

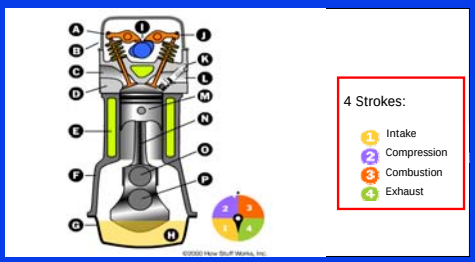
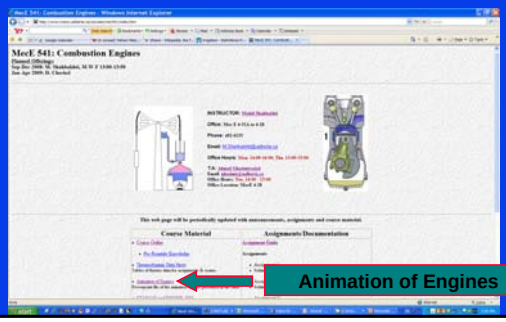


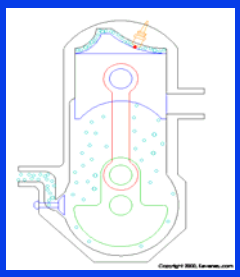
Image source: http://www.howstuffworks.com/

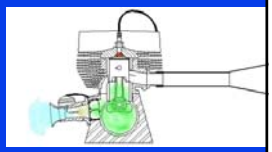
Password: MECE541

Password of second window: click on read only!



Two-stroke engine

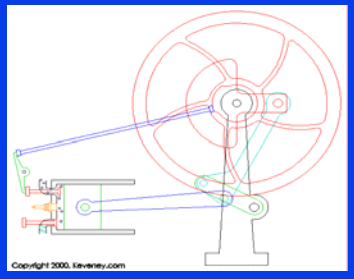


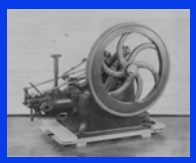


Reflected pressure wave on the fuel charge

Image source: http://www.keveney.com/Engines.html

Atkinson engine





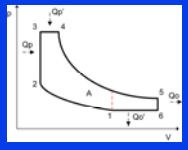


Image source: http://www.keveney.com/Engines.html, http://en.wikipedia.org

Wankel engine (a pistonless rotary engine)

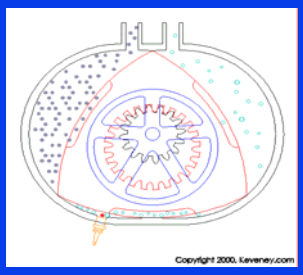


Image sources: http://www.keveney.com/Engines.html ; http://en.wikipedia.org

Wankel engine (Note to rotation of point A vs point B)

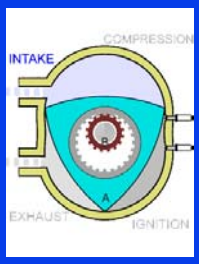


Image sources: http://en.wikipedia.org

HCCI

- **Homogeneous** – uniform distribution of fuel into intake air
- **Charge** – air and fuel mixture
- **Compression** – raising press. and temp. in cylinder to ignition condition
- **Ignition** – initiation of combustion

Engine Cycle Simulator User's Guide

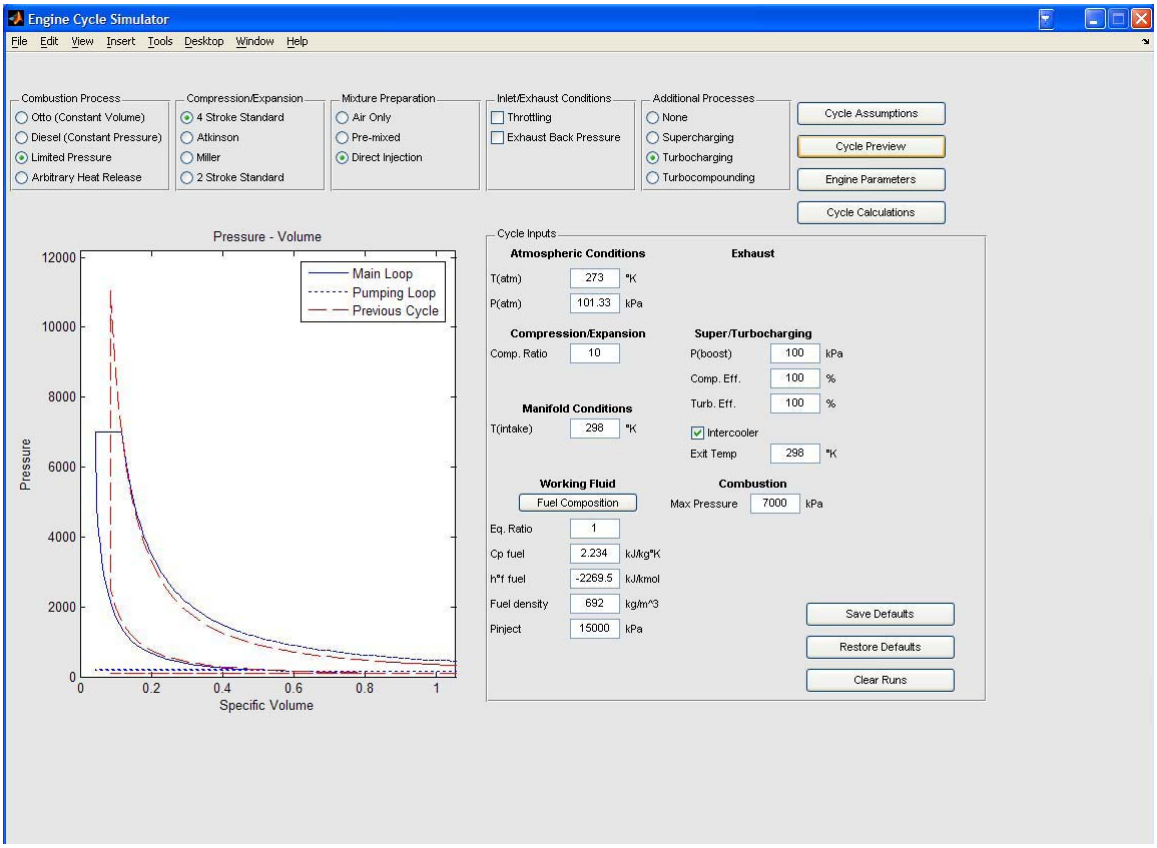
This document describes the engine cycle simulator program Engine_Sim07. The software has been developed by Prof. M. Dave Checkel.

Introduction

The Engine Cycle Simulator program was developed to let mechanical engineering students run internal combustion engine cycle simulations with a variety of input settings and options for thermodynamic treatment. The program enables the student to study the effect of cycle parameters on engine performance as well as the effect of various thermodynamic simplifications on the engine cycle.

User Interface

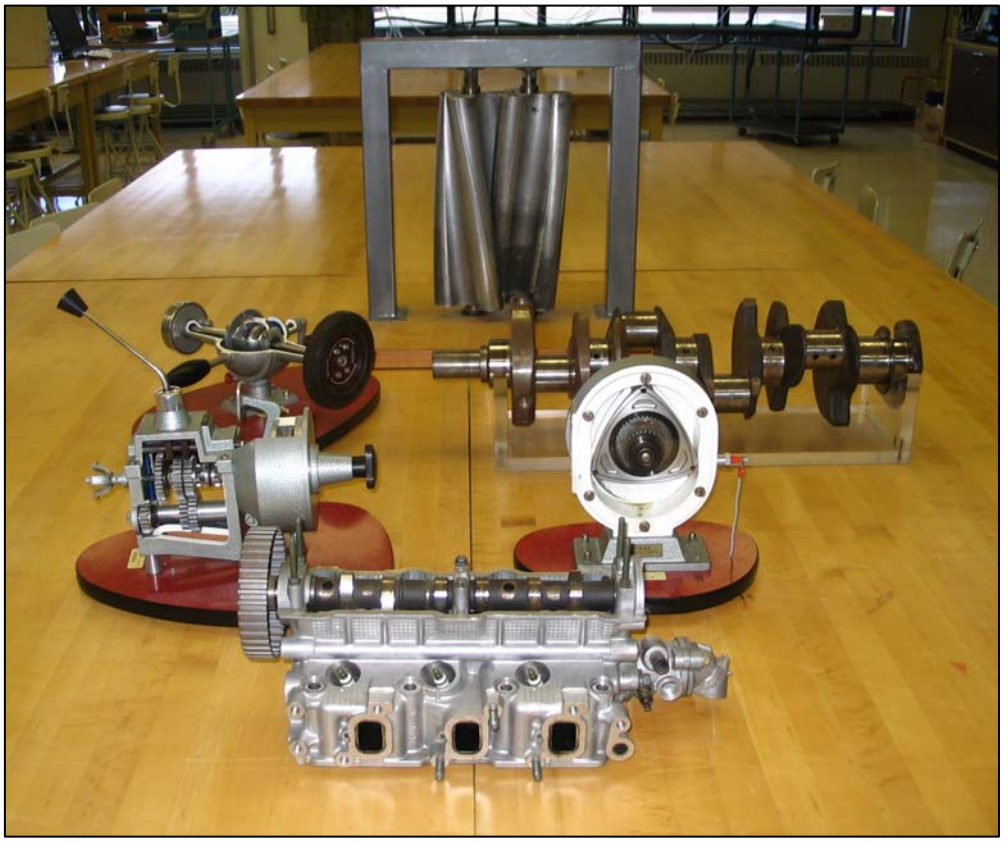
When the program starts, a screen similar to the following will be displayed:



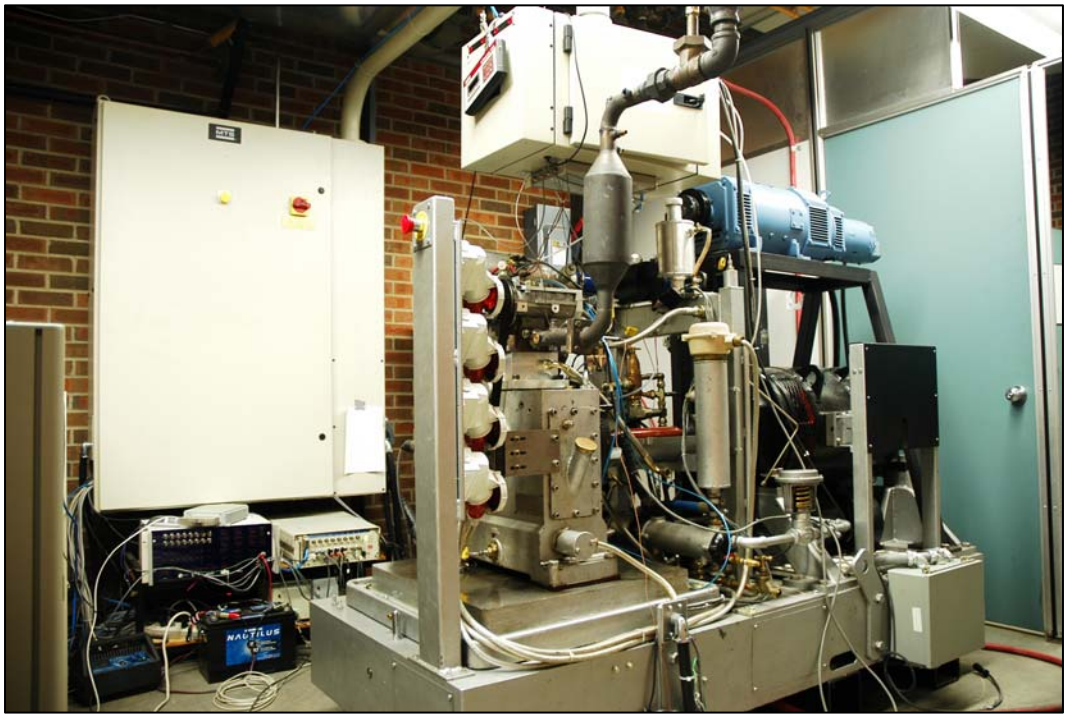
Most user input is made on this screen. The fluid properties, intake and outlet conditions, and cycle type are all defined on this page. Cycle assumptions can be changed by selecting the Cycle Assumptions button. Parameters affecting the overall engine output can be changed by selecting the Engine Parameters button. Various sections of the screen appear only if they are needed. **A Combustion Process, Compression/Expansion Process, and Mixture Preparation Option must be selected before a cycle simulation can be run.**

continued …

Sample equipment brought to classroom for illustration



The engine laboratory used to perform real experiments for students



Supporting Documentation
[4.4]

Contents:

- A sample designed active learning activity used in teaching MecE 541

- Samples from including “real life” examples in the course notes, assignments, and exams in MecE 541

MECE 541 - Active Learning #4

Please make a team of your friends around yourself
Discuss the following questions with your teammates
in 5 minutes.

Knock in SI engines follows a different trend than knock in diesel engines! How does knock intensity change with following variables?

Variable	Knock increases / decreases	
	in Diesel	in SI
$T_{manifold}$ ↑		
$P_{manifold}$ ↑		
Comp. ratio (C_r) ↑		
$T_{coolant}$ ↑		
EGR / residuals ↑		
Spark advance ↑	Not applicable	
Fast injection before ignition		Not applicable
Φ ↑		
Engine speed ↑		

-x- Real life example!

A bar friend has "shaved the head" on his engine and it ~~gives~~ says his new engine gives 20% more power with Cr of 10/1 v.s. 8.5/1 compression ratio. Do you believe this? Can you analyze this on the back of bar mat?

$$\text{Power} = \eta_{th} \times \dot{m}_f \times \underbrace{LHV}_{\text{lower healty value}}$$

η_{th}: varies

$\dot{m}_f$, LHV: assume fixed as related to displacement volume

assume $K = 1.4$,

$$\eta_{10} = 1 - \frac{1}{10^{0.4}} = 0.60$$

$$\eta_{8.5} = 1 - \frac{1}{8.5^{0.4}} = 0.57$$

ratio: $\frac{0.60}{0.57} = 1.05$

⇓

→ You can expect a ~~maximum of~~ 5% improvement v.s. 20%

note just to say ⇒ Although, K should be ≃ 1.3 -- ; You do not get 60% efficiency

How about using Argon with K of 1.67?

Lets assume to have an engine with 12:1 Cr in otto cycle using argon instead of air

$$\frac{\text{Power}_{Argon}}{\text{Power}_{Air}} = \frac{\eta_{Ar} \dot{Q}_{in}}{\eta_{air} \dot{Q}_{in}} = \frac{1 - \frac{1}{12^{(0.67)}}}{1 - \frac{1}{12^{(0.4)}}} = 1.3$$

$\dot{Q}_{in}$: assume same!

$12^{(0.67)}$: stays constant for inert gas (monatomic gas)

$12^{(0.4)}$: decrease with T increase

But what will happen to the temperature of combustion:

example: lets to assume to have an engine with $\dot{Q}_{in} = 250$ kW, 2 stroke, 60 rpm, $V_d = 120$L what is the peak temperature, T_3? Does this change if using argon? Assume intake condition at 298k (25°C)

$$T_2 = T_1 r_c^{k-1} = 298 \times 12^{0.4} = 805\text{K for air}, \quad T_2 = 1575\text{K for Argon}$$

THE UNIVERSITY OF ALBERTA

INTERNAL COMBUSTION ENGINES - MEC E 541 (Fall 2008)

ASSIGNMENT #1 Due Mon. Sept. 29, 2008 at 13:00 (hand in at the start of class)

1. Engine Performance and Dimensions (56 marks)

1.1 Engine Technology International had awarded "2008 best new engine of the year" status to the BMW 2-litre Diesel Twin Turbo engine used in the new 2008 BMW 123D. This four-cylinder direct-injection diesel has peak torque of 400 N.m @ 2000 rpm and peak power of 204 bhp @ 4400 rpm. The engine compression ratio is 16.0:1; the bore is 84.0 mm and the stroke is 90 mm.

a. What is the engine power band?

b. Is the displacement precisely 2 litres?

c. What is the engine bmep at peak torque? at peak power?

d. What is the mean piston speed at peak torque? at peak power?

e. If you were selecting transmission gears to give an economical cruise speed, what engine speed would you select as a base?

f. What is the bore/stroke ratio and what does this tell you about the engine design?

1.2 A medium-sized spark ignition industrial engine runs with a premixed stoichiometric mixture of Isooctane (C_8H_{18}) and air at 25°C and 95 kPa (at atmospheric conditions). Engine displacement is 19 liters and volumetric efficiency is 110% (turbocharged). The engine runs at 1500 rpm and is rated at 250 kW. (You can assume the Isooctane /air mixture is an ideal gas to find its density. Lower heating value of Isooctane is 44.3 MJ/kg.)

a. What is the engine's bmep (in kPa)?

b. What is the engine's volumetric consumption rate of fuel/air mixture, (in Litres/second)?

c. What is the engine's mass consumption rate of fuel, (in kg/second)?

d. What is the engine's thermodynamic efficiency, (in %)?

1.3 Your friend is planning to participate in an auto racing with his race car that has a V12 5-liter 24-valve BMW gasoline SI engine. Which of the following can be the specifications of his engine?

a) Compression ratio: 10
Bore/Stroke ratio: 1.3
Ratio of rod length to crank throw: 8

b) Compression ratio: 16
Bore/Stroke ratio: 0.8
Ratio of rod length to crank throw: 4.4

c) Compression ratio: 12
Bore/Stroke ratio: 0.5
Ratio of rod length to crank throw: 3.8

d) Compression ratio: 9.0
Bore/Stroke ratio: 1.1
Ratio of rod length to crank throw: 4.0

1.4 A 5 Litre V10 naturally aspirated GM gasoline engine is rated as having the peak IMEP 10 bar @2000 rpm. Peak brake power of the engine is 507 bhp @7750 rpm. What do you expect to be the engine speed at peak BMEP?

a) 1800 rpm

b) 2000 rpm

c) 2200 rpm

d) 7750 rpm

continued …

3. Problem Solving Questions

3.1 Energy density and heating value of fuels (18 Marks)

Hydrogen enthusiasts talk about the future 'Hydrogen Economy' when all hydrocarbon fuels are eliminated in favour of clean-burning hydrogen which produces no emissions except water vapour. (Given your Edmonton experience of ice fog, you know that even water vapour might cause problems). Because Hydrogen has a very low fuel storage density and some knock problems, spark ignition engines might use it as a blend with natural gas, (at least initially). This is called 'Hythane', a combination of HYdrogen + meTHANE.

An equimolar Hythane blend consists of 50% Hydrogen and 50% Methane by volume and is to be used as a vehicle fuel in spark ignition engines. The fuel is gaseous at all reasonable temperatures and pressures so you don't need to worry about phase changes. Chemical makeup and some properties for Hydrogen and Methane are found on the attached sheet.

(a) 4 marks
Write the chemical equation for combustion of a lean, Φ=0.9, mixture of equimolar Hythane and air burning to form complete combustion products.

(b) 6 marks
What is the Lower Heating Value of Hythane?

(c) 8 marks
What is the Volumetric Energy Density of this mixture at standard conditions? Is this higher or lower than the VED for pure Methane at the same equivalence ratio?

3.2 Estimation of exhaust emissions (12 Marks)

A current model car burns gasoline, (0.72 kg/Litre liquid density, chemical formula C_7H_{14}, LHV = 44,350 kJ/kg). The car is equipped with a 3-way catalytic converter to control emissions.

(a) 4 marks
If the car requires 10 kW to run at 90 km/hr and the powertrain is 20% efficient at producing that power, what will your fuel consumption rate be in L/100 km?

(b) 8 marks
What is the CO_2 emission rate in grams/km when the car is running down the highway at 90 km/hr (as per (a) above)? State your assumptions.

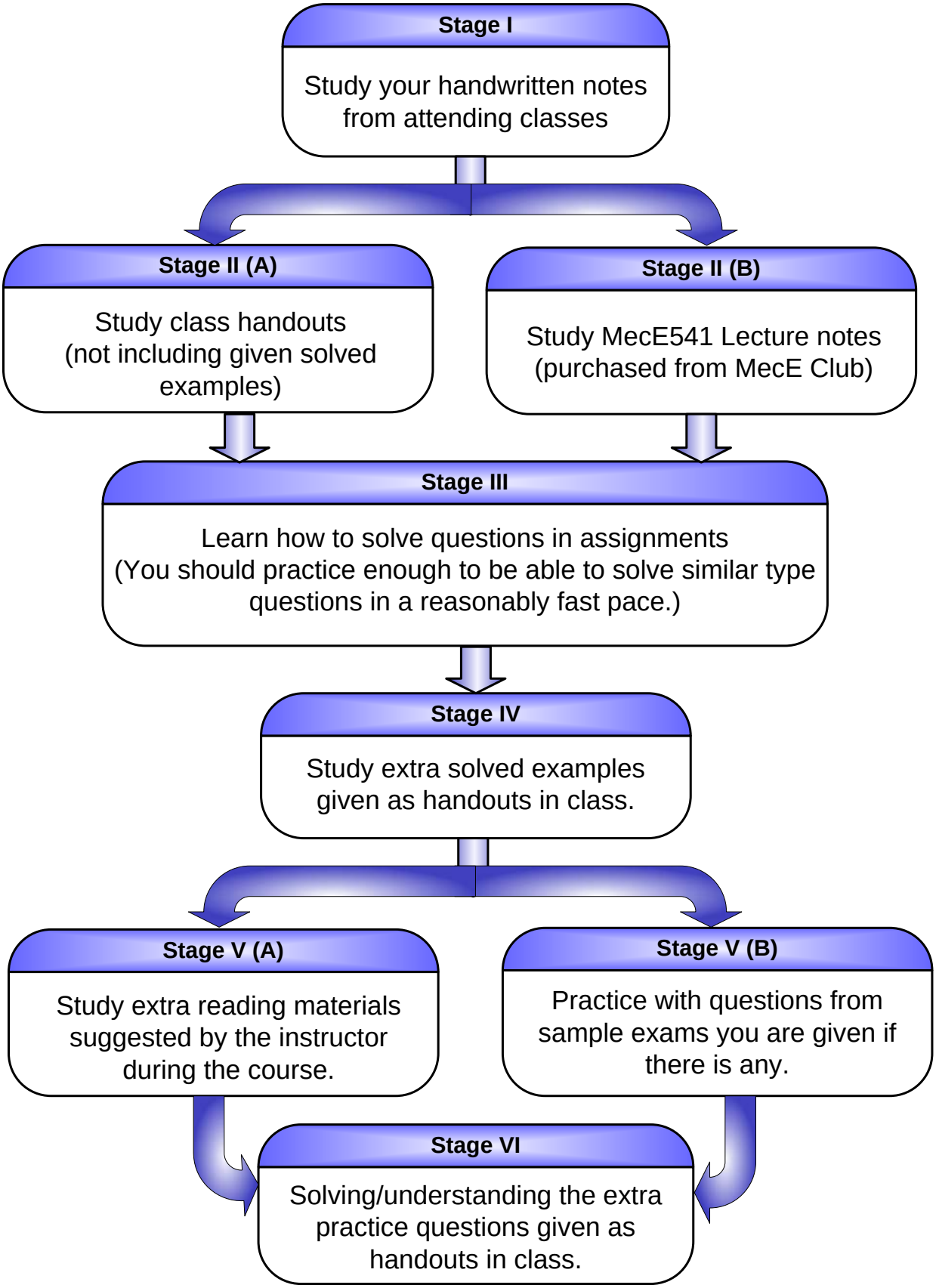
Supporting Documentation
[4.5]

Contents:

Students' preparation for exams

- Prepared model for studying exams in MecE 541
- Final exam guide for MecE 541 Fall 08
- Final exam review for MecE 541 Fall 08

Suggested model
for studying exams in MECE 541



GOOD LUCK!

Mec E 541 Final Exam Guide Fall 2008

- **Exam material**
  - The whole course from chapter 1 to chapter 5
  - Make sure you have reviewed all the class notes, handouts and course notes.
  - For the history section in chapter 1, you will be asked only for the parts discussed in the class.

- **Exam format**
  - Closed-book.
  - A two-sided letter-size sheet can be brought to write any important information you prefer not to memorize for the exam.
  - Exam structure: short answer questions + multiple choice questions + problems to calculate.
  - You do not need to bring any thing for thermodynamic properties. You will be provided with any required information.

- **Exam duration**
  - 2-3 hours in MecE 4-3 starting at 2:00 pm. Please be on-time!

- **Calculator policy**
  - You can bring a programmable calculator that should not have communication capability.

- **Suggestions for studying exam**
  - Follow the studying model posted on the website. This model shows the priority of different studying materials for the exam. Do not proceed to a next stage before completing a prior stage. Completing the first four stages is a minimum requirement for this exam.
  - Computer-simulation type questions will not be used in exam. However, you are supposed to be able to interpret the results from a computer program.

Posted on Nov. 30, 2008.

1. History of Engine Cycles & Machines

Progress:

- from machines which uses muscle power
- to machines which extracted power from the energy contained in water & wind,
- to machines which extracted power from working fluids heated by combustion:
  - -gunpowder explosion products
  - -steam
  - -air/fuel mixtures & combustion products.

What was important about the early history of engines?

A Radical Shifts in Technology

1. Progress from muscle power (low power)
   to mechanical power derived from wind/water energy.
2. Progress from wind/water energy (unreliable / large equipment)
   to fuel energy (easy to gather / store / utilize large amounts of energy)
3. Progress from external-combustion/heat-a-working-fluid/extract-work systems
   to internal-combustion/use-combustion-products-as-working-fluid systems

B Evolution in Engine Utility

4. Progress from very large machines (low speed / power density)
   to more compact machines with higher speed / power density

   e.g. windmill (~20m cube, 1 or 2 hp)
   to Newcomen (~10m cube, 5 hp)
   to Watt Engine (~7m cube, 20 hp)
   to Otto Engine (~1m cube, 20 hp)

   This involves working fluids with higher working pressures and more rapid release / transfer of energy within the machine.

5. Progress in materials & machine design to permit construction of the higher specific power engines with longer life

C Specific Improvements in Technology / Understanding to permit this progress

6. Switching from Hot Air / Gunpowder Exhaust to Steam
   for higher vacuum production (Papin, Savery)
7. Separating the boiler from the working cylinder
   to allow continuous heat input at the boiler (Newcomen)

8. Automatic Valving operated by the moving engine parts
   to make engine operation continuous and rapid (Newcomen)
9. Separating the condenser from the working cylinder
   to allow faster operation by separating the heat transfer from the working cylinder (Watt)
10. Double-acting pistons, 4-bar linkages, flywheel mechanisms, governor controls
    for high speed operation (Watt)
11. Thermodynamic analysis
    to measure / improve efficiency (Watt)
12. Pre-compression of the combustible mixture
    to improve specific power and efficiency (Otto/Langen)
13. Compression of pure air with later injection of fuel which ignites in the hot air. (Diesel)

2. Engine Properties and Parameters

- **Piston Engine Geometry and Typical Values**
  -Bore, Stroke, Displacement Volume, Clearance Volume
  -Compression Ratio, Expansion Ratio, Piston Speed
- **Engine Power, Torque and Efficiencies**
  -Power, Torque, Speed, MEP, SFC, η_f, η_v

3. Analysis of Combustion Engine Cycles

- **Air Standard Cycles for Cycles**
  -Standard Cycle Definitions
  -Working Fluid States and Energy
  -Thermodynamic and Volumetric Efficiency
  -Mean Effective Pressure, Power, Torque
- **Stoichiometry and Combustion Equations**
  -Simplified scheme for complete combustion
  -Measures of stoichiometry
    % Excess Air Air/Fuel Ratio
    Equivalence Ratio
    Lambda Ratio
    Mixtures with Fuel-bound Oxygen
  -Fuel Composition from Exhaust Gas Analysis
- **Properties of Real Fuel-Air Mixtures**
  -Mixture Density and Fuel State
  -Evaporation Effects
  -Mixture Energy Content and Volumetric Energy Density
- **Fuel-Air Mixture Consumption**
  -Energy Content and Power

4. Thermodynamics of Combustion Reactions

- **First Law Analysis of Processes With Combustion**

  -Enthalpy of Formation and Internal Energy of Formation
  -Enthalpy of Reaction and Heating Value
  -Adiabatic Flame Temperature at Constant Pressure
  -Adiabatic Flame Temperature and Pressure at Constant Volume

- **Chemical Equilibrium**

  -Equilibrium Constant from ΔG
  -Equilibrium Equation (including excess reactants and inert diluents)
  -Effects of T, P, Composition both in mathematical terms and as explanations
  -CO_2 dissociation, H_2O dissociation, Water-Gas Reaction, NO formation
  (note that NO formation is a direct, no-iteration calculation)

5. Detailed Cycle Analysis

-Otto Cycle, Miller Cycle, Limited Pressure Cycle, Ideal Diesel Cycle
-Gas Exchange Strokes, Residual Gas (actual and first estimate)
-Pumping Work, Compression Work, Expansion Work
(Diesel / Gasoline Direct Injection differences with air-only compression)
-Effect of throttling, supercharging, turbo-charging
-Net Work, Displacement Volume, IMEP, thermodynamic efficiency, indicated power
-Volumetric efficiency, mixture consumption rate, fuel consumption rate

Note: Most of your recent assignments have involved using ENGINE_SIM for engine cycle analysis. On an exam you might be given the cycle point properties and asked to complete the cycle analysis.

6. Combustion in Engines

- **Spark Ignition**

  -burning velocity, flame speed, temperature, pressure, turbulence effects
  -auto-ignition and knock,
  -combustion chamber design, swirl, squish and barrel-roll
  -ideal fuel properties
  -common pollutants, influence of operating factors
  -oxidizing and 3-way catalytic converters

- **Compression Ignition**

  -diffusion flame, auto-ignition, ignition delay

  -combustion chamber design, indirect and direct, swirl ratio

  -ideal fuel properties

  -common pollutants, influence of operating factors

7. Engine Pollutants

-Sources of emissions caused by combustion engines

-Hazards made by combustion engine emissions

-Standards and driving cycles to legislate automotive emissions

-Engineering solutions to reduce emissions

- Methods to decrease the rate of pollutant formation in engines
- Methods to decrease fossil fuels' consumption rate
- Methods for exhaust gas after-treatment

Supporting Documentation
[4.6]

Contents:

- The course teaching evaluation results for MecE 541
- Available teaching assistantship evaluations for MecE 420 and MecE 330

IDQ: Universal Student Ratings of Instruction
The University of Alberta's
Instructor-Designed Questionnaire System
Requisition Number: 552534-036

Instructor Report DEC 22, 2008
Academic Year 2008/09 IDQ Catalog=GFC
Class: MEC E 541 LEC A1
Instructor: **Shahbakhti, Mahdi**

	ITEM	RESPONSES FROM YOUR STUDENTS 1 SD	2 D	3 N	4 A	5 SA	YOUR MEDIAN	RANKS OF MEDIANS FROM OTHER CLASSES Tuky Fenc	25th %ile	50th %ile	75th %ile	Total Classes
	(Administrative Text for USRI Inserted Here)											
21	The goals and objectives of the course were clear.	0	2	0	14	9	4.3	3.3	4.1	4.4	4.6	370
282	The pace of the course was appropriate.	1	0	3	7	14	4.6	3.3	4.0	4.1	4.4	89
22	In-class time was used effectively.	2	0	1	8	14	4.6	3.2	4.1	4.4	4.7	370
13	The type of assigned work was appropriate to the goals of the course.	0	1	1	8	15	4.7	3.1	4.0	4.3	4.5	223
715	The frequency of exams or assignments was sufficient to provide adequate feedback.	0	1	2	8	14	4.6	3.2	4.0	4.2	4.4	89
506	The textbook and/or other reading material made a valuable contribution to the course.	0	1	5	12	7	4.0	2.7	3.8	4.0	4.4	89
562	Any instructional technology that was used in the course (e.g., notes on the Web) made a valuable contribution to this course.	0	2	2	16	3	4.0	2.9	3.8	4.0	4.4	89
23	I am motivated to learn more about these subject areas.	0	0	4	11	10	4.3	3.1	4.0	4.3	4.6	370
24	I increased my knowledge of the subject areas in this course.	0	0	1	12	12	4.5	3.5	4.3	4.6	4.8	370
25	Overall, the quality of the course content was excellent.	0	2	0	14	9	4.3	3.0	4.0	4.3	4.6	370
320	The laboratory was a valuable part of this course.	1	2	14	3	2	3.1	2.3	3.0	3.1	3.4	89
3051	The teaching assistant was well prepared	2	1	5	8	4	3.8	2.8	4.0	4.5	4.8	455
3009	The teaching assistant treated students with respect.	2	0	5	8	5	3.9	3.5	4.3	4.7	4.9	456
401	The teaching assistant(s) gave clear and understandable explanations.	2	0	8	5	5	3.5	1.6	3.0	3.2	3.9	89
3221	Overall, the teaching assistant was excellent.	2	0	5	8	5	3.9	2.8	4.0	4.4	4.7	456
674	The instructor spoke clearly.	1	1	1	12	10	4.3	3.3	4.2	4.6	4.8	370
51	The instructor was well prepared.	0	1	0	9	15	4.7	2.8	4.0	4.5	4.8	455
9	The instructor treated the students with respect.	0	0	0	7	18	4.8	3.5	4.3	4.7	4.9	456
11	The instructor was accessible outside of class.	0	0	2	8	15	4.7	3.1	4.0	4.3	4.6	1167
53	The instructor explained concepts clearly.	2	0	1	12	10	4.3	2.9	3.9	4.2	4.5	1320
630	The instructor demonstrated a good level of knowledge.	0	1	0	8	16	4.7	3.9	4.5	4.7	4.8	89
26	The instructor provided constructive feedback throughout this course.	0	3	2	5	15	4.7	3.2	4.1	4.3	4.6	370
221	Overall, this instructor was excellent.	1	0	1	7	16	**4.7**	2.8	4.0	4.4	4.7	456

Related to TA

Number of students responding to questionnaire: 25

Reference Group consists of FACULTY OF Engineering Grad-Level Classes
The reference data for the Universal Items is based on results beginning with Academic Year 2005/06 while other items use all data available.
Information about the contents of this report may be found on the Web at: http://www.ualberta.ca/AICT/TSQS/IDQ_reports.html

IDQ: Universal Student Ratings of Instruction
The University of Alberta's
Instructor-Designed Questionnaire System
Requisition Number: 604381-033

Instructor Report DEC 28, 2009
Academic Year 2009/10 IDQ Catalog=GFC
Class: MEC E 541 LEC A1
Instructor: Shahbakhti, Mahdi

	ITEM	RESPONSES FROM YOUR STUDENTS 1 SD	2 D	3 N	4 A	5 SA	YOUR MEDIAN	RANKS OF MEDIANS FROM OTHER CLASSES Tuky Fenc	25th %ile	50th %ile	75th %ile	Total Classes
	(Administrative Text for USRI Inserted Here)											
21	The goals and objectives of the course were clear.	0	1	3	19	8	4.1	3.3	4.1	4.4	4.7	497
282	The pace of the course was appropriate.	0	1	0	21	9	4.2	3.2	4.0	4.2	4.4	119
22	In-class time was used effectively.	0	0	3	19	9	4.2	3.2	4.1	4.4	4.7	498
13	The type of assigned work was appropriate to the goals of the course.	0	0	1	20	10	4.2	3.1	4.0	4.3	4.5	276
715	The frequency of exams or assignments was sufficient to provide adequate feedback.	0	2	1	19	9	4.2	3.3	4.0	4.2	4.4	119
506	The textbook and/or other reading material made a valuable contribution to the course.	1	3	5	12	10	4.0	2.8	3.8	4.0	4.4	119
562	Any instructional technology that was used in the course (e.g., notes on the Web) made a valuable contribution to this course.	0	1	9	13	6	3.9	2.9	3.8	4.0	4.4	118
23	I am motivated to learn more about these subject areas.	0	1	4	17	9	4.1	3.1	4.0	4.3	4.6	497
24	I increased my knowledge of the subject areas in this course.	0	1	1	12	17	4.6	3.5	4.3	4.6	4.7	497
25	Overall, the quality of the course content was excellent.	0	0	5	17	9	4.1	3.0	4.0	4.3	4.6	497
320	The laboratory was a valuable part of this course.	0	0	20	6	1	3.2	2.3	3.0	3.1	3.4	118
3051	The teaching assistant was well prepared	0	0	11	10	5	3.7	2.8	4.0	4.5	4.8	609
3009	The teaching assistant treated students with respect.	0	1	11	6	8	3.7	3.5	4.3	4.7	4.9	612
401	The teaching assistant(s) gave clear and understandable explanations.	0	0	12	10	4	3.6	1.7	3.0	3.2	3.9	117
3221	Overall, the teaching assistant was excellent.	0	0	11	11	4	3.7	2.8	4.0	4.4	4.7	612
674	The instructor spoke clearly.	0	4	4	16	7	4.0	3.2	4.2	4.6	4.8	498
51	The instructor was well prepared.	0	0	2	16	13	4.3	2.8	4.0	4.5	4.8	609
9	The instructor treated the students with respect.	0	0	1	11	19	4.7	3.5	4.3	4.7	4.9	612
11	The instructor was accessible outside of class.	0	0	8	11	11	4.1	3.1	4.0	4.3	4.6	1265
53	The instructor explained concepts clearly.	0	3	3	18	7	4.0	3.0	3.9	4.2	4.5	1411
630	The instructor demonstrated a good level of knowledge.	0	0	2	15	14	4.4	3.9	4.5	4.7	4.8	118
26	The instructor provided constructive feedback throughout this course.	0	1	3	15	12	4.3	3.2	4.0	4.3	4.6	498
221	Overall, this instructor was excellent.	0	1	2	14	14	4.4	2.8	4.0	4.4	4.7	612

Number of students responding to questionnaire: 31

Reference Group consists of FACULTY OF Engineering Grad-Level Classes
The reference data for the Universal Items is based on results beginning with Academic Year 2005/06 while other items use all data available.
Information about the contents of this report may be found on the Web at: https://www.aict.ualberta.ca/unit/client-services/TSQS/idq/IDQ_reports

GTA Evaluation – End of Term
Mechanical Engineering
To be completed by Instructor of course

Name of TA Mahdi Shahbakhti Course MECE 330 Term Fall '04

Instructor of course (person completing the form) Dr. Koch

Duties: (please check as many as apply)

- ✓ Instructing/demonstrating in lab
- ✓ Marking lab work
- ___ Marking quizzes
- ✓ Marking mid-term exams
- ✓ Marking assignments
- ✓ Lab set-up and clean-up
- ___ Office hours
- ___ Seminar leader
- ✓ Creating solutions for posting
- ___ Posting solutions on web
- ___ Other, please specify _____
- ___ Other, please specify _____

Strengths: (check as many as apply)

- ✓ Marks accurately*
- ✓ Good people skills*
- ✓ Clear verbal communication*
- ___ Available for students*
- ___ Performs tasks on time or ahead of time
- ✓ Knows course material
- ___ Requires little direction
- ___ Follows directions accurately
- ___ Other, please specify _____

* Obtain input from students in class if necessary

Areas for Improvement: (check as many as apply)

- ___ Needs to mark more accurately*
- ___ Needs to improve spoken English*
- ___ Work on time management
- ___ Pay attention to instructions (write down if necessary)
- ___ Should attend the lectures for course to familiarize self with material
- ___ Other, please specify _____

Overall Performance: (please check the one that most applies)

- ___ Exceeds my expectations (Excellent)
- ✓ Meets my expectations and occasionally exceeds expectations (Very Good)
- ___ Meets expectations (Satisfactory)
- ___ Sometimes meets expectations but occasionally fails to meet expectations (Marginal)
- ___ Rarely/never meets expectations (Unsatisfactory)

Note: Consistent high levels of performance will be noted and used to nominate TA for awards, performance bonuses, etc. With "Marginal" or "Unsatifactory" performance, TA will be required to meet with APO to discuss remedial actions.

M. Shahbakhti _____ Bob Koch _____

(Student's signature)** (Instructor's signature)

**Signing signifies that student has read and understood the evaluation. It does not signify agreement with the evaluation. If student does not agree, that should be discussed with the instructor.

Please return to Wendy Bryan, APO, no later than December 17.

GTA Evaluation – End of Term
Mechanical Engineering
To be completed by Instructor of course

Name of TA Mahdi Shahbakti Course Mec E 420 Term Winter '06

Instructor of course (person completing the form) Koch

Duties: (please check as many as apply)

- ✓ Instructing/demonstrating in lab
- ✓ Marking lab work
- ✓ Marking quizzes
- ___ Marking mid-term exams
- ✓ Marking assignments
- ✓ Lab set-up and clean-up
- ✓ Office hours
- ___ Seminar leader
- ✓ Creating solutions for posting
- ___ Posting solutions on web
- ✓ Other, please specify taught 2 lectures
- ___ Other, please specify _____

Strengths: (check as many as apply)

- ✓ Marks accurately*
- ✓ Good people skills*
- ✓ Clear verbal communication*
- ✓ Available for students*
- ✓ Performs tasks on time or ahead of time
- ✓ Knows course material
- ✓ Requires little direction
- ✓ Follows directions accurately
- ✓ Other, please specify good presentation skills

* Obtain input from students in class if necessary

Areas for Improvement: (check as many as apply)

- ___ Needs to mark more accurately*
- ___ Needs to improve spoken English*
- ___ Work on time management
- ___ Pay attention to instructions (write down if necessary)
- ___ Should attend the lectures for course to familiarize self with material
- ___ Other, please specify _____

Overall Performance: (please check the one that most applies)

- ✓ Exceeds my expectations (Excellent)
- ___ Meets my expectations and occasionally exceeds expectations (Very Good)
- ___ Meets expectations (Satisfactory)
- ___ Sometimes meets expectations but occasionally fails to meet expectations (Marginal)
- ___ Rarely/never meets expectations (Unsatisfactory)

Note: Consistent high levels of performance will be noted and used to nominate TA for awards, performance bonuses, etc. With "Marginal" or "Unsatifactory" performance, TA will be required to meet with APO to discuss remedial actions.

M. Shahbakhti
(Student's signature)**

Bob Koch
(Instructor's signature)

**Signing signifies that student has read and understood the evaluation. It does not signify agreement with the evaluation. If student does not agree, that should be discussed with the instructor.

Please return to Wendy Bryan, APO, no later than April 14.

Supporting Documentation
[4.7]

Contents:

- The award letter and four letters of support from my teaching mentor and students for the 2009 Zita and John Rosen Teaching Award at the University of Alberta

- Award certificate for outstanding volunteer contribution in Let's Talk Science national program

- Letter of Alan Wharmby Memorial Graduate Award in Mechanical Engineering at the University of Alberta

Graduate Students' Association
15th Annual Awards Night

Zita and John Rosen Graduate Teaching Award

Mahdi Shahbakhti

Ben Whynot, GSA President
March 12, 2009

PURPOSE: Graduate Student Teaching Award

The purpose of this award is to give special recognition to graduate student instructors who are especially skilled and dedicated teachers. Any current graduate student at the University of Alberta is eligible for this award. The nominator for this application must be familiar with the student's work in teaching.

THEMES: GSA Awards

The GSA Awards recognize three distinct yet interrelated and intertwined themes. Successful nominations will provide demonstrable evidence of the application of these themes to the purpose of the award.

Excellence	*Leadership*	*Community*
These prizes are meant to recognize members of our student body and other campus communities who are truly exceptional in their academic and/or professional endeavors. Relevant to this theme would be things such as previous certificates or awards for distinction. Publications and conference participation also can serve as indicators of scholarly excellence.	In addition to excellent scholars and professionals, the GSA Awards value leadership in academic, occupational, and community contexts. Leadership comes in many forms and serves a variety of functions. Fundamentally, however, leadership is about bringing people together to accomplish worthwhile goals and/or to achieve positive change.	Community service can be practiced in many ways. Individuals can choose to contribute to their academic or campus community or to the betterment to the broader civic, provincial, national, or global community. Whatever the specific arena, a dedication to the wider public good is the common theme of this category.

CRITERIA: Graduate Student Teaching Award

☐ Excellence and innovation in teaching	☐ Leadership in engaging students	☐ Contribution to teaching and the University community

SPONSOR: Graduate Student Teaching Award

As founders of City Lumber Corporation and Lumber City Millwork in 1937, Zita and John Rosen have created a successful business committed to supporting the city of Edmonton, Western Canada and post-secondary learning. Avid supporters of outstanding teaching at the University of Alberta, the Zita and John Rosen Teaching Award sponsored by City Lumber will enable a graduate student to engage in activities that reward and recognize excellence in teaching, ground-breaking scholarship and contributions to the community. Zita & John Rosen are pleased to present $1000 to an outstanding principle instructor.

The gold place award, valued at $1500, as well as five silver place awards, valued at $500, will be awarded to outstanding graduate student teachers courtesy of the AEGS fund.

SUPPORTING DOCUMENTS

A Complete Nomination Package Will Contain...

- ☐ Completed Nomination Package
- ☐ Two letters of support clearly demonstrating how the nominee meets all the stated criteria and describing the nominee's role in the course (each 1 page maximum)
  - *At least one of the letters must be written by a student taught by the nominee*
- ☐ Copies of Teaching Evaluation Summaries.
  - *In the event evaluations from the department are not available, a letter from the department must be provided in its place.*

UNIVERSITY OF ALBERTA

Department of Mechanical Engineering

4-9 Mechanical Engineering Building
Edmonton, Alberta, Canada T6G 2G8

www.engineering.ualberta.ca/mece

Tel: 780 492 3598
Fax: 780 492 2200

23 January, 2009

Ben Whynot, Chair
GSA Awards Selection Committee

regarding: Graduate Student Teaching Award nomination for Mahdi Shahbakhti

I am pleased to nominate Mahdi Shahbakhti for the Graduate Student Teaching Award based on his outstanding performance teaching MecE 541 Combustion Engines in Fall 2008.

I first got to know Mahdi as a graduate student researcher supervised by another professor in our group and as a teaching assistant working with me. I became convinced that his combination of academic ability, work ethic and personal skills would make him an excellent academic so I looked for a way that he could get some real teaching experience to add to his resume. We have a strict policy that courses should be taught by professors, not sessionals. This led to creating an extra section of our Combustion Engines course with Mahdi as instructor and myself as teaching mentor. (The Chair's idea being that I could be the back-up instructor if there was any problem with the course). As I had hoped would be the case, Mahdi did an exceptional job of preparing for and teaching the course. This led to not only a complete lack of problems, but also a very high student evaluation of teaching excellence.

On the student evaluations, Mahdi achieved a 4.7 average rating for teaching excellence; most of his students rate him 5/5. He achieved this exceptional value, (despite being a first-time teacher), by a combination of hard work on preparation, excellent pedagogical practises and a real concern for his students. One part of the hard work involved a detailed review of the student course pack as well as developing additional examples and illustrative material. The students in his section really appreciated the complete command of the material that this gave him. I see that students in future sections will also benefit because his work improved the course pack. Being thoroughly prepared allowed Mahdi to control the course pace and also spend time on good pedagogical practices. He developed a number of active learning exercises designed to give the students more insight into the topic than they could get from lectures and problem solving alone. In a complex subject like combustion engines, it's easy to get bogged down teaching thermodynamics so the active learning sessions helped to keep students focussed on the big picture and provided more of those "I see!" moments that really enhance the learning experience. Finally, Mahdi's teaching ratings reflect the personal interest he took in getting to know his students and truly help them to learn the material. The common theme through his students' comments is that he was readily available beyond normal hours and that he provided detailed feedback and personal assistance to make certain each student could meet the learning objectives. (An issue in preparing this nomination is that a number of students were inspired to write a supporting letter and I'm trying to pick the one that best describes both his teaching skills and his student interactions).

In summary, Mahdi Shahbakhti has provided a superb example of university-level teaching and an inspiration to all of us on how we can improve our teaching. The fact that he has done this as a graduate student bodes well for his future and that of the academic community.

M. David Checkel, Professor

January 28, 2009

Subject: **Reference letter for Mahdi Shahbakhti (applicant for GSA Teaching Award)**

To: the Graduate Students' Association,

As Mahdi's former student from MEC E 541 (combustion engines), I would highly recommend him for the teaching award. Although this was his first time teaching the course, he instructed effectively and with much heart.

Excellence and innovation in teaching

Mahdi taught with a standard course pack (which gave structure to the course), but he did not settle with teaching using the usual methods. In seeking to relate the theory to the actual operation of engines, he found an extensive number of animations to show in class. At the same time, he would point out various facts of interest that were not obvious in the animations. Sometimes, he would also mention ongoing engine research that would improve on existing problems shown in the animations. He really wanted his students to understand current technologies and broaden their minds to coming technological advancements.

He also invested a lot of effort to help students learn the course material. In previous years, students were expected to learn the material based on solved examples in the course pack. But there were few examples, because few textbooks exist that are relevant to our course. When a couple of students requested more examples, Mahdi made a special effort to dig through whatever resources he could find and printing out examples and suggested readings for the class. If this were an easy task, previous MEC E 541 instructors would have already done so and put it in the course pack. Mahdi demonstrated great character as an instructor in doing this for us.

Because this course has no labs, Mahdi arranged for two demonstrations for us to see a test engine. In short, he did a lot to go beyond the nominal duties of an instructor.

Leadership in engaging students

Mahdi actively sought to memorize the names of the 30+ students in his class from the first day. He also encouraged students to give feedback on how he could better meet their needs (and because he did this, students felt comfortable asking him for more examples). Through all this, an atmosphere was created where students felt comfortable approaching Mahdi. After class, students would often ask him about how the theory could be applied to cars.

Contribution to teaching

Mahdi tried to initiate more active learning by getting students to engage in discussions. He would ask them to get in groups to discuss and theorize on expected results from changing various engine parameters. He would then gather the class together so students could present their guesses and reasoning to each other. Although there were few opportunities to do this, I came to learn those particular topics very easily.

One of the innovations I most appreciated was his development of a "model for studying exams." Before exams, he would go over his model to help us understand the course expectations and what study preparations should be prioritized.

Despite having never taught this course before, Mahdi had high expectations of himself as an instructor. I greatly appreciate how he invested a lot of effort to teach the course effectively and to make it easier for students to engage with the material.

Sincerely,

Dated: 19 January 2009

To,
The Graduate Students' Association
Killam Centre for Advanced Studies
1-37 Triffo Hall
University of Alberta
Edmonton, AB T6G 2E1

Subject: Letter of reference for Mahdi Shahbakhti (Application for Graduate Student Teaching Award)

It gives me immense pleasure in writing this reference letter to support Mr. Mahdi Shahbakhti's application for the Graduate Student Teaching Award.
I have known Mr. Mahdi Shahbakhti as my lecturer for the Combustion Engine course (MecE 541- Fall Term 2008). He is one of the best teachers I have ever come across during my study career. He not only teaches extremely well but also cares a lot about the level of understanding of each student. He has excellent classroom management style and possesses excellent verbal and written communication skills by which we were able to complete our course at a very comfortable pace.

He has excellent work ethics and a high level of efficiency. He never missed any classes and all the assignments and term exams were immediately graded and returned back to us. This shows his commitment towards his students. He also made sure to spend time to give feedback for the assignments to make everyone understand what the most common mistakes were, and provided individual feedback to each student with regards to his/her weak and strong points. He posted the correct solutions online after an assignment so that everyone can track their mistakes and learn from it right away.

While teaching he made the classroom interactive by giving us quizzes and active learning sheets. What I most admire about him apart from his dynamic teaching style is that he was always accessible even after class times. Personally I cannot recall how many times I went up to him for discussing course problems but he always greeted me with a smiling face and helped me out with my course problems.

Mr. Mahdi Shahbakhti is a very hard working, versatile, knowledgeable and congenial teacher I have ever come across and I highly recommend him for the Graduate Student Teaching Award.

Yours Sincerely,

M Engg Program (Masters of Engineering- Mechanical Engineering)
Department of Mechanical Engineering
University of Alberta
Edmonton, AB

[redacted]

January 13, 2009

Graduate Students´ Association
Killam Centre for Advanced Studies
1-37 Triffo Hall
University of Alberta
Edmonton, AB T6G 2E1

RE: Graduate Students' Association Teaching Award

I am writing this letter to comment on Dr. Mahdi Shahbakhti regarding the Graduate Students' Association Teaching Award. Dr. Shahbakhti was my instructor last semester in Fall 2008, and the course I was taking from him was MEC E 541, Combustion Engine.

Dr. Shahbakhti was one of the most memorable instructors in my five years of school life. He taught the class as a graduate student, however, his instruction skill was flawless and outstanding so that I could have a strong understanding of the course during the semester. I could see his passion of teaching students in every single session, and the course materials that he prepared were more than enough to help students with their studies.

The way Dr. Shahbakhti interacted with the students and led them to participate in the class was excellent. He often had discussions with students regarding the class topics and let people express their own ideas in class. He intended to make each student to be part of the class, and he guided students to think rather than cramming his knowledge to them. He made himself available to students anytime even after his office hours and gladly helped them to have a better understanding of the course.

Overall, I strongly believe that Dr. Shahbakhti is one of the greatest instructors at the University of Alberta, and I am honored that I could give a comment on him regarding this award. If you have any questions or need further information, please contact me via email at jaeseo@ualberta.ca.

Thank you.

Sincerely,

[redacted]

science

Award certificate

sciences

Most Youth Reached

Is hereby granted to:

Mahdi Shahbakhti

For his outstanding volunteer contributions to the Let's Talk Science Partnership Program at the University of Alberta in 2007-2008

Including: Reaching 170 youth, and committing 46 volunteer hours

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Gord McNickle – Coordinator

Justin Chun – Coordinator

Ryan McKenzie - Coordinator

July 2/2008

Date

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April 21, 2008

Mr. Mahdi Shahbakhti
Department of Mechanical Engineering

Dear Mahdi

Congratulations. You have been awarded the Alan Wharmby Memorial Graduate Award in Mechanical Engineering.

This award is valued at $500. Once you have accepted this award, you will receive payment within 60 days.

This award recognizes your participation in extra-curricular activities and your positive contributions to the spirit of our graduate student body. Please accept our best wishes in the continuation of your graduate program.

Yours truly

Dr. Larry Kostiuk, Chair

End of
Supporting Documentation

Mahdi Shahbakhti

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mahdish@mtu.edu

www.me.mtu.edu/~mahdish/Shahbakhti_Teaching.html